STRUCTURAL REINFORCEMENT SYSTEM FOR AN AUTOMOTIVE VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/499,669, filed on September 3, 2003. The disclosure of the above application is incorporated by reference herein.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] The present invention generally relates to automotive vehicle structure and more particularly to a cross-vehicle structural reinforcement for an automotive vehicle.

[0003] Cross-vehicle body stiffness within automotive vehicles is important in reducing torsional twist and vibration of the body, but also improves the ride and handling of the vehicle. This issue is especially important for convertible vehicles where the removal of the traditional fixed roof structure further decreases vehicle stiffness to the point where four door convertible roof vehicles have been essentially impractical to achieve with conventional body structure. Furthermore, U.S. Federal Motor Vehicle Safety Standard ("FMVSS") 214 relates to side impact collision protection for vehicles. This governmental standard employs a moving barrier, equivalent to a truck bumper, which impacts the vehicle generally at and below a belt-line of the front door and B-pillar. FMVSS 214 puts an added premium on cross-vehicle stiffness.

[0004] U.S. Patent No. 1,694,546 entitled "Motor Car," which issued to Lancia on December 11, 1928, and U.S. Patent No. 5,788,322 entitled "Body Structure for a Rear Carriage of a Convertible," which issued to Wolf et al. on August 4, 1998, have both attempted to provide some cross-vehicle structure. It is noteworthy, however, that both constructions are attached to a fixed seat back and/or passenger compartment panel. Furthermore, the Lancia construction appears to lack any cross-vehicle structural support anywhere near the belt-line that would significantly resist side impacts or belt-line torsion, especially for a modern unibody construction vehicle.

[0005] In accordance with the present invention, a structural reinforcement system is provided for an automotive vehicle. In another aspect of the present invention, an upper structural beam is employed which extends in a cross-vehicle direction adjacent to a vehicle belt-line. A further aspect of the present invention provides an upper structural beam with a recessed central portion. Yet another aspect of the present invention uses a structural reinforcement system in a convertible roof vehicle.

[0006] The present invention is advantageous over conventional constructions, in that the present invention significantly improves cross-vehicle resistance to side impact collisions and provides torsional stiffness sufficient for use with a large four door vehicle, such as one having a convertible roof. The present invention further acts as a seat frame attachment thereby reducing parts and saving redundant weight as a multifunctional device. Moreover, the same structure that adds stiffness also retains rear passenger devices such as airbags, entertainment systems and the

like. Additional features and advantages of the present invention will be shown and described with reference to the following description and appended figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is a side elevational view showing a first preferred embodiment automotive vehicle employing a structural reinforcement system of the present invention, with a hard-top convertible roof in a retracted position and with the left side doors removed;

[0008] Figure 2a is a side elevational view showing the first preferred embodiment automotive vehicle employing one structural reinforcement system, with the hard-top convertible roof in a raised position and with the left side doors removed;

[0009] Figure 2b is a side elevational view showing a second preferred embodiment automotive vehicle employing a structural reinforcement system of the present invention, with a soft-top convertible roof in a raised portion and with the left side doors removed;

[0010] Figure 3 is a perspective view as seen from behind the right rear corner, showing an alternate embodiment automotive vehicle employing a structure reinforcement system of the present invention, with a slidably retracting roof in a raised position;

[0011] Figure 4 is a partially fragmentary, rear diagrammatic view, as seen from line 4-4 of Figure 1, showing a first preferred embodiment structural reinforcement system of the present invention;

[0012] Figure 5 is a diagrammatic side view showing the first preferred embodiment structural reinforcement system made by a stamping;

[0013] Figure 6 is a diagrammatic side view showing the second preferred embodiment structural reinforcement system made by a hydroforming;

[0014] Figure 7 is a perspective view showing a fragmentary third preferred embodiment automotive vehicle employing a structural reinforcement system of the present invention;

[0015] Figure 8 is a diagrammatic, partially cross-sectional view, taken along line 8-8 of Figure 4, showing the second preferred embodiment structural reinforcement system;

[0016] Figure 9 is a diagrammatic, cross-sectional view, taken along line 8-8 of Figure 4, showing the first preferred embodiment structural reinforcement system;

[0017] Figure 10 is a cross-sectional view taken along line 10-10 of Figure 4, showing the second preferred embodiment structural reinforcement system;

[0018] Figure 11 is a cross-sectional view taken along line 10-10 of Figure 4, showing the first preferred embodiment structural reinforcement system;

[0019] Figure 12 is a diagrammatic rear view, as seen from line 4-4 of Figure 1, showing a third preferred embodiment structural reinforcement system of the present invention;

[0020] Figure 13 is a diagrammatic rear view, as seen from line 4-4 of Figure 1, showing a fourth preferred embodiment structural reinforcement system of the present invention;

[0021] Figure 14 is a perspective view showing the fourth preferred embodiment structural reinforcement system of the present invention;

[0022] Figure 15 is a diagrammatic rear view, as seen from line 4-4 of Figure 1, showing a fifth preferred embodiment structural reinforcement system of the present invention;

[0023] Figure 16 is a diagrammatic top view showing a second alternate embodiment structural reinforcement system of the present invention;

[0024] Figure 17 is a diagrammatic side view showing a third alternate embodiment structural reinforcement system of the present invention; and

[0025] Figure 18 is a diagrammatic, perspective view showing the first preferred embodiment system of the present invention but with a soft top convertible roof.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] An automotive vehicle according to the present invention has a body, a convertible roof and a structural reinforcement system 19. In a first preferred embodiment of vehicle 21, shown in Figures 1 and 2, the convertible roof is a retractable hard-top roof including a front hard-top section 23, a middle hard-top section 25 and a rear hard-top section 27. The hard-top sections are interconnected by a linkage assembly (not shown) driven by an automatic actuator 29, such as an electric motor or hydraulic cylinder. The convertible roof is movable from a raised and closed position above front passenger seats 31 and rear passenger seats 33 in a passenger

compartment 35, as shown in Figure 2, to a retracted and open position within a roof storage compartment 37, as shown in Figure 1. Roof storage compartment 32 is a trunk with a dual opening decklid, or a bootwall, forward and separated from a trunk, covered by an automatically openable tonneau cover. Such a hard-top roof and linkage assembly is disclosed in U.S. Patent Serial No. 10/245,973, now U.S. Patent No. 6,695,386, entitled "Vehicle Retractable Hardtop Roof," which was invented by Michael T. Willard and filed on September 18, 2002, which is incorporated by reference herein.

[0027] Referring to Figure 18, a soft top convertible roof 41 is also usable with the present invention, and is disclosed in U.S. Patent Serial No. 10/403,362, now U.S. Patent No. 6,695,385, entitled "Vehicle Convertible Roof," which was invented by Eric W. Lange and filed on March 31, 2003; this disclosure is incorporated by reference herein. Soft top roof 41 includes a top stack mechanism including left and right, front, center and rear side rails, 42, 43 and 44, respectively, with four spanning roof bows 45 and multiple linkages 48. An electric motor or hydraulic actuator 46 automatically drives the mechanism and a pliable roof cover 47 is attached to and covers roof bows 45. Furthermore, Figure 3 shows multiple sliding roof panels and a slidably retracting backlite or back window, which are employed with the present invention in a first alternate embodiment. This is disclosed in PCT Publication No. WO 02/096685 entitled "Automotive Vehicle with Open Air System" which was invented by Doncov et al. and published on December 5, 2002; this disclosure is also incorporated by reference herein.

[0028] Returning to the preferred embodiment of Figures 4-6, structural reinforcement system 19 is made up of multiple cross-vehicle upper and lower beams 51 and 53, respectively, and interconnected diagonal and vertical beams 55 and 57, respectively. Upper beam 51 is positioned adjacent a beltline 61 of the vehicle and lower beam 53 is attached to a sheet metal floor pan 63 of the vehicle. The outboard vertical beams 57 are welded, riveted or otherwise secured to B-pillars 65 of the vehicle. Beams are preferably integrally hydroformed as a single steel piece, as shown in Figures 4, 6, 8, 10, 12, 13 and 15. In another preferred embodiment, beams are integrally stamped from sheet metal as a single piece, as shown in Figures 5, 9 and 11. Gussets 91 are attached to a center tunnel 93 of vehicle and to outboard rocker panels 95 of the unibody vehicle. Alternately, separated created beams can be welded together.

[0029] Reference should be made to Figures 7 and 8 where a polymeric center, floor trim console 101 extends from a front passenger area 107, through a recess 103 in upper beam 51 and into a rear seating area 109, between bucket front seats and bucket rear seats. Polymeric trim panels 105 also cover the exterior of structural system 19. Door hinge hardware 121 can be secured directly to reinforcement system 19 by bolts, rivets or welding. A decorative B-pillar facia 123 is attached to structural system 19 in an alternate embodiment. An electronic entertainment system 141, such as including an audio or video compact disc player, movie player, radio or the like, is located in a central pocket of each side of structural system 19 for use by the rear seat passengers. Furthermore, an inflatable air bag

system 151 (see Figure 12) may be provided in each pocket of structural system 19, the beams of which are angled to properly channel the deployment forces into the floor and B-pillars. Moreover, roll bars 161 (see Figure 4) are optionally secured to upper beam 51 on each side of the vehicle's fore-and-aft centerline 163.

[0030] Figure 13 illustrates a fourth preferred embodiment structural reinforcement system 19 of the present invention. This exemplary structural reinforcement system 19 includes an upper beam 161, a lower beam 163, and pairs of crossing diagonal beams 165 and 167 spanning between the upper and lower beams outboard of a middle, recess 169 where upper and lower beams 161 and 163 converge. Ends of upper and lower beams 161 and 163 are directly affixed to adjacent and generally vertical B-pillars 65 and rocker panels 95, without supplemental vertical beams. A simulated bumper 171, according to FMVSS 214, is shown adjacent to the vehicle beltline which is generally aligned with the intersection between upper beam 161 and B-pillar 65.

[0031] Figure 14 shows structural reinforcement system 19 with a floor-mounted, trim console 101 centrally extending in a fore-and-aft centerline direction of the vehicle. In this variation, console 101 extends between bucket front seats 173 and either is interrupted by, passes above or passes below beam recess 169. The rear end of console 101 terminates forward of a bench rear seat 175.

[0032] A fifth preferred embodiment system 19 is shown in Figure 15. In this embodiment, a generally straight and horizontal upper beam 181 is connected to a lower beam 183 by multiple branching, intermediate beams 185. Lower beam 183 has

a raised central segment 187 to circumvent the floor tunnel. Beams 181 and 183 are attached to B-pillars 65 and rocker panels 95. A central, component cluster assembly 189 is mounted to system 19 within an aperture between the beams for use by the rear seat passengers. Component cluster assembly 189 includes audio and video entertainment systems 191, heating/ventilating/air conditioning ducts and controls 193, a storage compartment 195, communications devices 197, and the like.

[0033] Referring to Figure 16, a second alternate embodiment of a structural reinforcement system 251 includes a structural beam 253 extending in a primarily cross-vehicle direction. Ends 255 of beam 253 are welded or otherwise fastened to B pillars 257. Beam 253 has a pair of arcuately curved segments 259 joining at a forwardly extending central segment 261 which can be optionally secured to a floor panel 263 or fore-and-aft extending tunnel attached thereto, by a generally vertical bracket or gusset. A front seat 265 is located forward of each curved segment 259 and each seat back may have a top view curve conforming with the adjacent curved shape of beam 253. A floor mounted, interior trim console (such as that shown in Figure 14) may be provided between seats 265 and can either extend above center segment 261 for use by both front and rear seat passengers, may extend below central segment 261 such that the center portion of beam 253 creates an aesthetic styling element in the vehicle as well as providing a functional reinforcement, or a two-piece console may sandwich central segment 261 of beam 253. The rear view shape of beam 253 can extend straight across the vehicle or may have a central depression such as that shown in Figures 4 and 7.

[0034] Figure 17 illustrates a third alternate embodiment structural reinforcement system 301 of the present invention. In this embodiment, a structural beam 303 extends in a generally straight (when viewed from the top and rear) orientation between the B-pillars or other upstanding structural members of the automotive vehicle adjacent the rocker panels. Beam 303 is an enclosed and hollow polygon, here shown with four sides when viewed in cross-section, which can be created from and extruded or hydroformed steel. Rear sections 305 of metal seat tracks 307 are attached to beam 303 by welded or riveted brackets 309. Front sections 311 of seat tracks 307 are attached to a metal floor panel 313 by welded, riveted or bolted on brackets. Front seats 315, or other passenger seats, and their respective seat movement mechanisms 317 are attached to seat tracks 307. Exemplary seat movement mechanisms 317 are disclosed in U.S. Patent No. 5,575,531 entitled "Vehicle Power Seat Adjuster with End Driven Lead Screw Actuation" which issued to Gauger, et al. on November 19, 1996, and is incorporated by reference herein. Space is provided below beam 303 and the adjacent portion of seat tracks 307 so as to maximize passenger compartment leg room and foot room. Beam 303 is secured to the vehicle well below a belt line area but may be useful in trucks, vans, sport utility vehicles and other situations that serve to add the required vibrational stiffness, minimize cross-vehicle and diagonal twisting of the vehicle body, while also improving crashworthiness during side impact. Thus, beam 303 advantageously serves as a multifunctional part.

[0035] While various aspects of the structural reinforcement system have been disclosed, it should be appreciated that variations may be made which fall within

the scope of the present invention. For example, additional accessories can be attached to any of the structural reinforcement beams disclosed herein such as folding tables, lamps, telephones, computers and the like. Furthermore, the beams can alternately be manufactured from composite materials such as glass-filled polymers, metal inserts molded within polymers, and the like. The cross-vehicle beams and reinforcements can also be employed behind rear seats or in front of instrument panels although various advantageous of the present invention may not be fully achieved. Structural system 19 is preferably employed in a convertible vehicle having four, side passenger doors 213 but may also be used in a stretch limousine having four or more passenger doors and a stationary roof. Bullet-proof armor is optionally mounted along a cross-car plane parallel and internal to trim panels 105. Furthermore, it should be appreciated that alternate beam shapes can be employed. It is intended by the following claims to cover these and any other departures from the disclosed embodiments that fall within the true spirit of the invention.